Two features of figure 1 require further consideration. The high-pressure belt does not cross the shore line in an east and west direction, but rather from a direction somewhat south of west to north of east. This is due to the presence of the continental HIGH over the United States in winter and to the greater northward movement of the thermal equator over the arid regions of northwestern Mexico and the southwestern States in summer than over the adjoining ocean. In the summer the so-called permanent HIGH is central over the sea, but in winter is central over the land. So in the spring and fall there are periods in which the shift of position is taking place and in which the pressure is fairly uniform over the whole coast. There is, therefore, considerable uncertainty as to the exact location of the center line of the HIGH during these periods. This probably accounts for the peculiar shape of curve I as drawn. If we look upon the permanent HIGH as an actual HIGH, central over the Rocky Mountain States in winter and over the Pacific in summer, the winds issuing from it along the coast would be expected to blow from the northwest in summer and from the southeast in winter. This may account for the southeast winds recorded at Eureka. Elsewhere the effect seems to be inappreciable. It may be noted, in passing, that while these curves were drawn without any reference to pressure charts, the positions of the belts as given here are in good agreement with the charts compiled from the data collected by the Weather Bureau.

A study has been made of the winds of the Mississippi Valley, but without satisfactory results. The local topography seems to play a very large part in determining the prevailing wind directions at inland points. In conclusion some samples of the confusing and disconcerting sets of data met with are given in the following table:

TABLE 1.—*Prevailing winds during all months of the year.*

| Station. | Jan. | Feb. | Mar. | Apr. | May | June |
|---|---|---|---|---|---|---|
| St. Paul, Minn. | nw. | nw. | nw. | nw. | nw. | se. |
| Minneapolis, Minn. | nw. | nw. | nw. | ne. | ne. | s. |
| Duluth, Minn. | sw. | ne. | ne. | ne. | ne. | ne. |
| Sandy Lake Dam, Minn. | nw. | nw. | nw. | se. | e. | se. |
| Keokuk, Iowa | nw. | nw. | nw. | se. | s. | s. |
| Sublett, Mo. | nw. | nw. | sw. | sw. | sw. | sw. |

| Station. | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|
| St. Paul, Minn. | se. | nw. | se. | se. | se. | nw. |
| Minneapolis, Minn. | s. | s. | s. | s. | nw. | nw. |
| Duluth, Minn. | ne. | ne. | ne. | ne. | sw. | sw. |
| Sandy Lake Dam, Minn. | nw. | nw. | s. | nw. | nw. | nw. |
| Keokuk, Iowa | s. | s. | s. | nw. | nw. | nw. |
| Sublett, Mo. | sw. | sw. | sw. | sw. | nw. | sw. |

Taken in pairs these stations are in practically the same latitude and are not more than fifty or so miles apart in an east and west direction.

### DISCUSSION.

*Prof. A. J. Henry* suggested that in studies of this kind a consideration only of the prevailing wind might show apparent diversities which do not exist. For instance, in the Mississippi Valley, S. winds and NW. winds may blow for about the same number of hours. At one station the NW. may prevail by a narrow margin, while at a neighboring one the S. may prevail. The use of wind roses would eliminate such apparent discrepancies.

## SOME DISCUSSIONS OF WIND OBSERVATIONS: DEESA AND KARACHI, INDIA.[1]

By W. A. HARWOOD.

[Abstracted from review by R. De C. Ward, in *Geogr. Rev.*, 1919, 8:281-282.]

These papers are excellent as examples of methods of discussing wind records, in addition to their value as contributions to the local climatology of subtropical northwest India. "The wind roses show very clearly the seasonal variation in wind direction at Deesa [over 200 miles NE. from the Gulf of Cutch] and the prevalence of winds from westerly and southerly points at Karachi [on the Sind coast at the extreme northwestern end of the Indus delta], except in December and January. Many other diagrams are also included."—ED.

[1] A discussion of the anemographic observations recorded at Deesa from January, 1879, to December, 1904. A discussion of the anemographic observations recorded at Karachi from January, 1873, to December, 1894. With an introduction by G. T. Walker. Diagrs. *Memoirs Indian Meteorol. Dept.*, vol. 19, pp. 275-335. Calcutta, 1915.

## EVAPORATIVE CAPACITY.[1]

By ROBERT E. HORTON, Consulting Engineer,

[Voorheesville N. Y.]

(Author's abstract.)

The object of this paper is to furnish data showing the relative evaporation rates under standard conditions at different localities throughout the United States. The term "evaporative capacity" is defined by the author as:

> "The maximum rate of evaporation which can be produced by a given atmospheric environment from a unit area of wet surface exposed parallel with the wind, the surface having at all times a temperature exactly equal to that of the surrounding air."*

The evaporative capacity at 112 U. S. Weather Bureau stations has been determined from the meteorological normals of temperature, wind velocity, and humidity, by means of the author's evaporation formula. The coefficients in the evaporation formula were determined by experiments covering two years on a standard Weather Bureau evaporation pan. Maps are given showing evaporative capacities for day and night and summer and winter conditions, and tables are given showing monthly evaporative capacities and day and night time temperatures for each of the 112 stations. The application of the maps and data to problems in hydrology, water consumption by plants and agriculture, is discussed.

[1] Presented before the American Meteorological Society, New York, Jan. 3, 1920.
*Cf. MONTHLY WEATHER REVIEW, Nov. 1919, 47:810 (1st col.).

## DEVICE FOR OBTAINING MAXIMUM AND MINIMUM WATER SURFACE TEMPERATURES.[1]

By ROBERT E. HORTON, Consulting Engineer.

Figure 1 is a sketch of a wooden float, which I have found very satisfactory for the purpose of obtaining maximum and minimum water surface temperatures in standard Weather Bureau evaporation pans. In taking the readings, the minimum thermometer is simply tilted up on the pivoted support in the usual manner, to set it. The maximum thermometer is held in position on the pivot support by a wire hook marked A.

[1] Presented before the American Meteorological Society, New York, Jan. 3, 1920.

After the reading is taken this hook is lifted, the thermometer taken off from the support and held firmly in hand with the bulb end down, and given one or more sharp rapid downward swings over the evaporation pan, so that any water thrown off goes back into the pan. The same device has been used for the purpose of taking water surface temperatures in lakes and ponds.

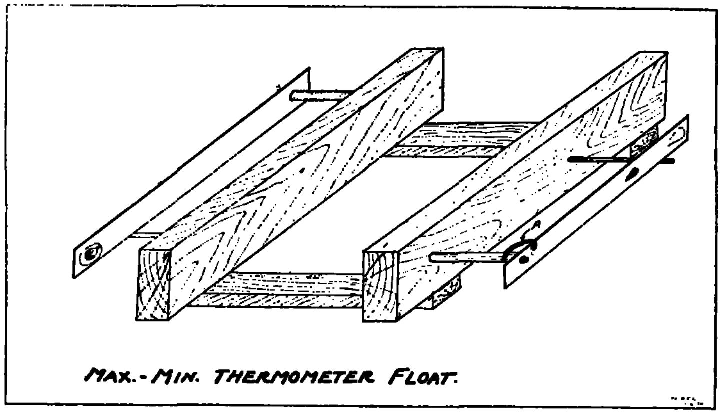


FIG. 1.—Wooden float for obtaining maximum and minimum water-surface temperatures.

In view of the fact that there are so many evaporation records now being kept where records of water surface temperatures, really the most important factor, are omitted, and in further view of the importance of water surface temperature records in lakes and ponds, this note may be of value. Such records are very scarce.

## FORM AND AREA FACTORS FOR EVAPORATION.

By W. GALLENKAMP.

(Abstract from Meteorologische Zeitschrift, January-February, 1919, 36:16-22.)

Using small circular atmometer surfaces from 2 to 8 centimeters in diameter, the relative masses of water lost from different sized atmometers were determined. In the first two series of experiments, four atmometers of different sizes were rotated on a frame having arms of 28 centimeters radius. In three subsequent series, atmometers of different diameters were exposed without rotation in the free air. In the sixth series, atmometers of 2.4 and 7.5 centimeters diameter, respectively, were rotated on a frame, one of each size being placed at 14 and one at 28 centimeters radius.

As a result of these experiments the author concludes that—

(1) The mass of evaporation from different sized atmometers subject to wind action increases according to a form of parabolic law with the diameter of the atmometer.

(2) The relative depth of evaporation from atmometers of different sizes subject to wind action varies inversely as about the 0.4 power of the diameters.

(3) The reduction in evaporation depth with increased diameter is practically independent of the wind velocity.

The author concludes that the reduction in evaporation depth with increased area of surface in the wind is due to the carrying forward of vapor from the windward to the leeward side of the atmometer. As a check on this conclusion and on the formula, an experiment was carried out using two atmometers, each 1.5 by 7 centimeters. One of these was placed with its longer axes perpendicular to the wind direction, and the other with its longer axis parallel with the wind. For similar exposures, these two atmometers should give equal depths of evaporation in perfectly still air. When exposed in the wind, the relative depths of evaporation were as 1.80 to 1, the atmometer with its longer axis parallel with the wind giving the smaller result. The author's inverse 0.4 power rule gives a ratio 1.85 to 1 for this case.

The subjoined table shows the relative masses of evaporation (not depths) from atmometers of different sizes, and the corresponding evaporation ratios computed by the author's formula—

$$\frac{V_1}{V_2}=\frac{B_1}{B_2}\sqrt{\frac{L_1^{1.2}}{L_2^{1.2}}}$$

in which $v_1$ and $v_2$ are the volumes of loss by evaporation in the atmometers having lengths $L_1$ and $L_2$ parallel with the wind, and widths normal to the direction $B_1$ and $B_2$. Reduced to the terms of relative depths of evaporation, this formula becomes—

$$\frac{E_1}{E_2}=\frac{d_2^{0.4}}{d_1^{0.4}}$$

for circular atmometers, in which $d_1$ and $d_2$ are the diameters of the atmometers.

The author points out that his formula is not based on sufficient experimental data, nor do the experiments cover a sufficient range of diameters so that it can be safely applied beyond the limits of the experiments. The formula would indicate zero evaporation depth from an indefinitely large area exposed to the wind, whereas experiments show that the evaporation depth from very large areas approaches as a minimum a limit not far from one-half the depth lost from an evaporation pan of the ordinary sizes used in the field experiments. It appears probable therefore that the law governing the area factor is exponential rather than parabolic.[1]

The author gives results of experiments on the evaporation loss from atmometers exposed to wind action, using distilled water containing various percentages of salt. The mean reduction in evaporation rate in percentage of that for distilled water for different solutions was as follows:

| | | | | |
|---|---|---|---|---|
| Per cent salt | 1.5 | 3.0 | 4.5 | 6.0 |
| Per cent reduction | 8.3 | 12.0 | 15.2 | 18.1 |

—*R. E. H.*

### DISCUSSION.

The experimental work referred to in this paper is not only insufficient, as stated by the author, but perhaps also imperfectly planned. The pans are surprisingly small, and, besides, the turbulence incident to whirling is quite certain to introduce serious irregularities in the rate of evaporation. Nevertheless, the conclusion that the quantity of evaporation is proportional to the 1.6 power of the diameter (for circular vessels) is surprisingly near the theoretical value, 1.5, deduced by Jeffries. (Phil. Mag., 35, p. 273, 1918.)—*W. J. H.*

[1] An exponential formula for area factor which gives results consistent with experience for large areas, derived theoretically from the assumption of stream-line transport of vapor from windward to leeward over an evaporation surface, is given in Engineering News Record, Apr. 27, 1917, pp. 196-199.—*R. E. H.*